

FIELD STUDY OF DISPOSED WASTES  
FROM ADVANCED COAL PROCESSES  
QUARTERLY TECHNICAL PROGRESS REPORT

May 1989 - July 1989

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## 1.0

### OBJECTIVES

The Department of Energy/Morgantown Energy Technology Center (DOE/METC) has initiated research on the disposal of solid wastes from advanced coal processes. The objective of this research is to develop information to be used by private industry and government agencies for planning waste disposal practices associated with advanced coal processes. To accomplish this objective, DOE has contracted Radian Corporation and the North Dakota Energy & Mineral Research Center (EMRC) to design, construct and monitor a limited number of field disposal tests with advanced coal process wastes. These field tests will be monitored over a three year period with the emphasis on collecting data on the field disposal of these wastes.

There has been considerable research on the characteristics and laboratory leaching behavior of coal wastes -- a lesser amount on wastes from advanced coal processes. However, very little information exists on the field disposal behavior of these wastes. Information on field disposal behavior is needed (a) as input to predictive models being developed, b) as input to the development of rule of thumb design guidelines for the disposal of these wastes, and c) as evidence of the behavior of these wastes in the natural environment.

## 2.0

### OBJECTIVES FOR THE CURRENT REPORTING PERIOD

The specific objectives for the reporting period of May, 1989 to July, 1989 were as follows:

- Review fourth site candidates;
- Obtain site access for the Freeman United site;
- Select an ash supplier for the Illinois site and initiate subcontracts for on-site work; and

- Commence construction of the Freeman United test cell.  
Obtain waste for the Colorado Ute test site.

### 3.0 ACTIVITIES FOR THE REPORTING PERIOD

#### Ohio Edison Site

Site Construction. During the last reporting period the north and south test cells were constructed and filled with LIMB fly ash.

Figure 1 presents a schematic of the test cell excavation. Approximately 600 to 700 cubic yards of earth were excavated for each of the two cells. The bottom surface of each cell was sloped slightly toward the toe. Considerable seepage and runoff was observed upslope from the cells. A series of diversion trenches were dug to route this water around the cell area. The truck turn-around area up-slope of the cells was surfaced with rock, which was later found to be blast furnace slag.

Figure 2 presents a simple schematic of the LIMB process as configured during the filling of the waste test cells. Lime is injected in the boiler "nose" through six nozzles mounted on the boiler wall. The reacted lime and fly ash are collected in electrostatic precipitators with storage hoppers below to collect the precipitator ash.

Ash from the electrostatic precipitators drops to hoppers beneath the banks of precipitators. From the hoppers the ash is conveyed pneumatically, as needed, to an ash storage silo. During the period of filling the test cells, there were several occasions when lime injection was stopped. During these periods, conventional fly ash was collected and conveyed to the ash silo. To avoid "contaminating" the test cells with this non-LIMB ash, it was necessary to pay close attention to the plant operation and the level of LIMB ash in the ash silo. When lime was not injected, the level of LIMB ash in the silo was noted, and only that amount of ash was sent to the test cell (making allowances for mixing and rat-holing of the fly ash with the LIMB ash).

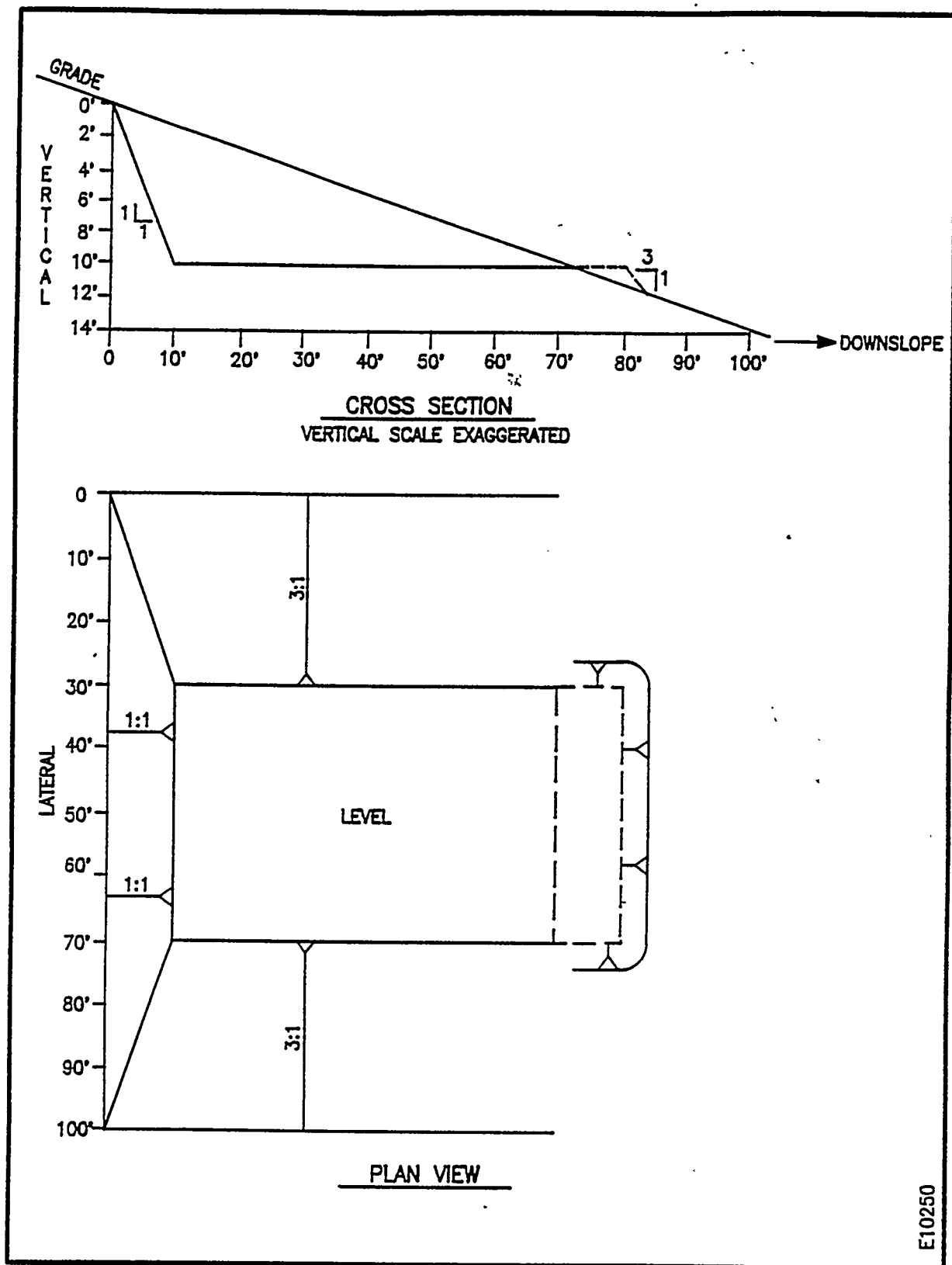


Figure 1. Schematic of Test Cell Excavation

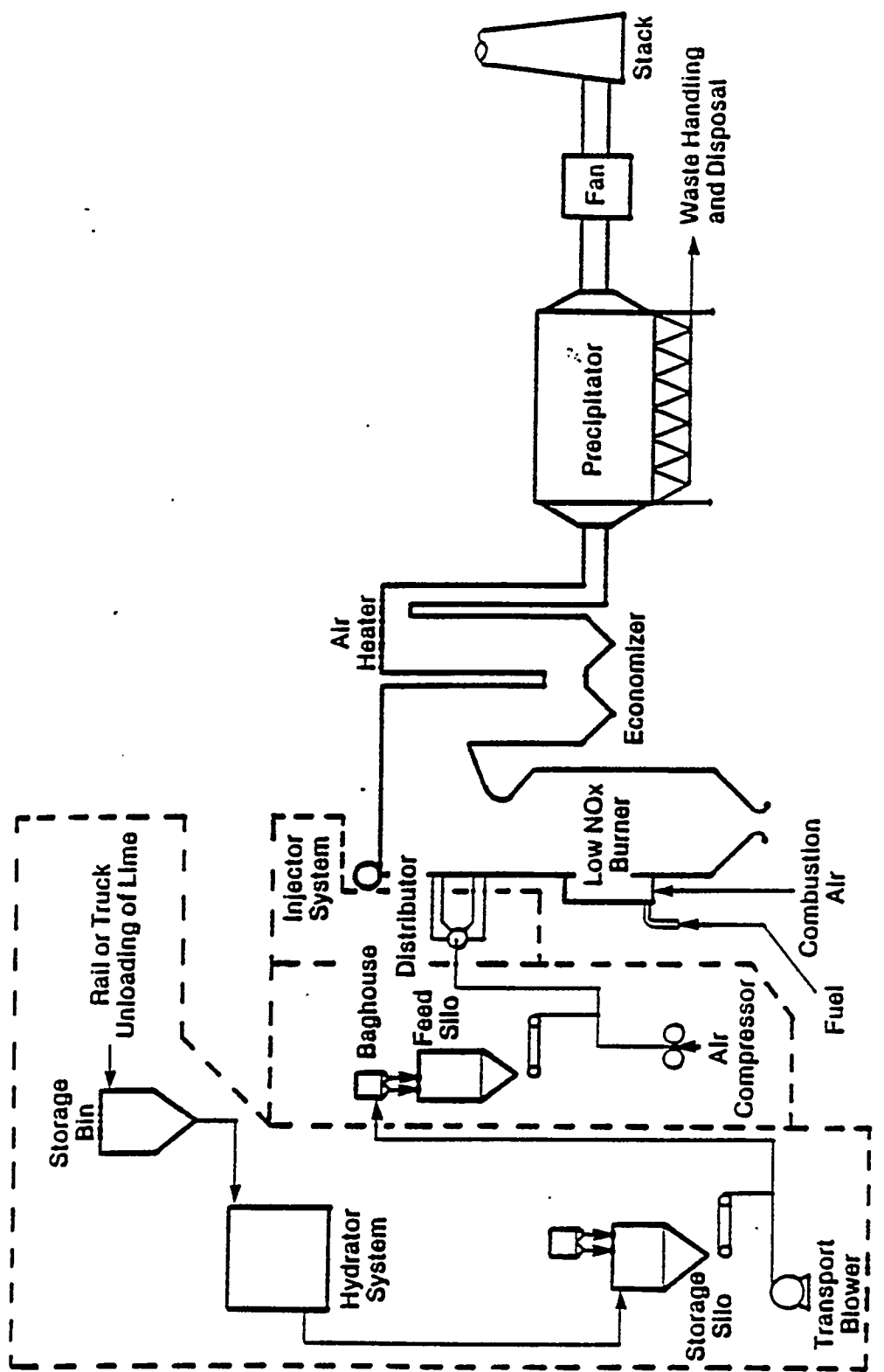


Figure 2. Schematic of LIMB Demonstration at Ohio Edison Edgewater Plant

Tables 1 and 2 present operating data for the plant during the filling of the north and south (first and second) test cells. The Unit 4 boiler was operated at approximately 75% load, or 75 MW. Coal flow was nominally 60,000 lbs/hr, and sorbent (lime) flow was nominally 7000 lbs/hr, representing a stoichiometry (calcium/sulfur) of about 1.5.

Tables 3 and 4 present analyses of the coal for the two periods representing filling of the north and south test cells, respectively. The coal had an ash content of slightly over 10%, and about 2.5% sulfur (as received basis).

The storage silo had a flat-bottom with high pressure air diffusers to fluidize the ash for loading trucks. Beneath the silo were provisions for unloading the ash either wet (conditioned) or dry. The test cells (and adjacent landfill) were only filled with conditioned ash.

A Dravo wet-mixer was used to condition the ash. The mixer consisted of a near-horizontal cylindrical mixer, approximately 5-feet in diameter and 10-feet long, with a series of paddles arranged to provide mixing and to convey the ash through the mixing chamber.

Water was sprayed on the ash from points within the mixer at a rate needed to prevent dusting. A water feed rate of 120 gpm was possible, although the operators generally added water at a rate between 50 and 80 gpm. It generally took 8 to 12 minutes to load a truck with a capacity of about 15 tons, or 28 cubic yards. A volume of water between 600 and 900 gallons was therefore added to each truck load of LIMB ash. Tables 5 and 6 present the measured moisture contents of the ash in the trucks as they left the plant for the north and south cells respectively (a fraction of the water added to the ash in the conditioners was lost to evaporation because of the heat generated during conditioning).

Three trucks were generally used to transport ash from the silo to the test cells. (These same trucks are used when ash is hauled to the Edge-water landfill.) The size of the trucks varied slightly, but they had an

TABLE 1. PLANT OPERATING DATA DURING FILLING OF NORTH TEST CELL

Site: Ohio Edison  
Sample Type: Edgewater Plant Operating Conditions, Unit 4

Condition	Units	Dates
		April 7, 1989 - April 17, 1989
Load	MW	80 (50-90)
Ca/S	--	1.5 (1-1.75)
SO <sub>2</sub> efficiency	%	60 (40-80)
Sorbent flow	lb/hr	6,000 (4,000-7,000)
Coal flow	Klb/hr	70 (40-75)
Coal sulfur	wt %	2.5
Coal nitrogen	wt %	1.4
SO <sub>2</sub> emission	lb/MMBtu	NA
O <sub>2</sub>	vol %	8.5 (8-10)
Boiler efficiency	%	86 (85-89)
Heat rate, plant		NA
Gas temperature, nose		2,300 (2,200-2,400)
CO <sub>2</sub> in Hum	vol %	NA
CO <sub>2</sub> out Hum	vol %	NA
H <sub>2</sub> O in Hum	vol %	NA
H <sub>2</sub> O out Hum	vol %	NA

Value given is estimated median. Values in parentheses represent range.  
NA - Not analyzed

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TABLE 2. PLANT OPERATING DATA DURING FILLING OF SOUTH TEST CELL

Site: Ohio Edison  
 Sample Type: Edgewater Plant Operating Conditions, Unit 4

Condition	Units	Dates
		February 24, 1989 - March 1, 1989
Load	MW	75 (45-95)
Ca/S	--	1.5 (1.3-1.75)
SO <sub>2</sub> efficiency	%	45 (20-60)
Sorbent flow	lb/hr	7,000 (4,000-10,000)
Coal flow	Klb/hr	60 (40-80)
Coal sulfur	wt %	2.9
Coal nitrogen	wt %	1.4
SO <sub>2</sub> emission	lb/MMBtu	2.75 (2.25-4.5)
O <sub>2</sub>	vol %	9 (7.5-10)
Boiler efficiency	%	87 (86-88)
Heat rate, plant		10,200 (10,000-10,500)
Gas temperature, nose		2,200 (1,800-2,300)
CO <sub>2</sub> in Hum	vol %	10 (7.5-11)
CO <sub>2</sub> out Hum	vol %	10 (7.5-12)
H <sub>2</sub> O in Hum	vol %	5 (2.5-7.5)
H <sub>2</sub> O out Hum	vol %	6 (2.5-7.5)

Value given is estimated median. Values in parentheses represent range.

TABLE 3. COAL ANALYSES DURING FILLING OF NORTH TEST CELL

Site: Ohio Edison  
 Sample Type: Coal Collected After Pulverizer

Analyte (as received, %)		
Volatile matter	%	34.24
Fixed carbon		NA
H <sub>2</sub> O		7.31
Ash		11.02
S		2.50
HV (Btu/lb)		11,979
C		66.50
H		4.49
N		1.37
Cl		NA
O		6.81

TABLE 4. COAL ANALYSES DURING FILLING OF SOUTH TEST CELL

Site: Ohio Edison  
Sample Type: Coal Collected After Pulverizer

Sample No:	LIMB1236	LIMB1247	LIMB1245	LIMB1253	LIMB1259
Date :	890223	890224	890227	890228	890302

Analyte (as received %)

Volatile matter	36.68	35.58	36.38	33.82	32.63
Fixed carbon	48.67	49.59	49.39	50.89	51.21
H <sub>2</sub> O	5.31	4.96	4.61	4.73	4.94
Ash	9.34	9.87	9.62	10.56	11.22
S	2.34	2.37	2.37	2.45	2.46
HV	12534	12414	12585	12492	12301
C	69.74	69.55	69.8	69.38	68.39
H	4.72	4.52	4.67	4.49	4.45
N	1.46	1.51	1.45	1.38	1.43
Cl	NA	NA	NA	NA	NA
O	7.09	7.22	7.48	7.01	7.11

Analyte (Dry basis %)

Volatile matter	38.74	37.44	38.14	35.50	34.33
Fixed carbon	51.40	52.18	51.78	53.42	53.87
Ash	9.86	10.39	10.08	11.08	11.80
S	2.47	2.49	2.48	2.57	2.59
HV	13237	13062	13193	13112	12940
MAF HV	14685	14576	14673	14747	14672
Ash index	7.45	7.95	7.64	8.45	9.12
SO <sub>2</sub> index	3.73	3.81	3.76	3.92	4.00
C	73.65	73.18	73.17	72.82	71.94
H	4.98	4.76	4.90	4.71	4.68
N	1.54	1.59	1.52	1.45	1.50
O	7.49	7.60	7.84	7.36	7.48

TABLE 5. TONNAGE AND MOISTURE CONTENT OF ASH DELIVERED TO NORTH TEST CELL

Site: Ohio Edison  
 Sample Type: Ash from Trucks

Load No.	Date	Time	Net Tonnage	Measured % Moisture (Dry basis)
1	89/02/23	0735		
2	89/02/23	0810		
3	89/02/23	0815		
4	89/02/23	0845		A composite sample was formed by combining each grab sample taken from approximately each of the 70 ash trucks arriving at the test site over a 4-day period.
5	89/02/23	0930		
6	89/02/23	0945		
7	89/02/23	1015	Total =	
8	89/02/23	1050	213.44	
9	89/02/23	1100	tons	
10	89/02/23	1110		
11	89/02/23	1230	(Ave. 13.34)	Analysis of a 1-quart portion of the composite sample indicated the prehydrated (conditioned) LIMB ash sample had average moisture content of 25.6%
12	89/02/23	1235		
13	89/02/23	1305		
14	89/02/23	1400		
15	89/02/23	1405		
16	89/02/23	1430		
17	89/02/24	0735		
18	89/02/24	0755		
19	89/02/24	0815		[Range - 25.4-25.9%]
20	89/02/24	0845		
21	89/02/24	0905		
22	89/02/24	0930		The average moisture of the LIMB ash put in the north cell should therefore be in the range of 25%-26%.
23	89/02/24	0935		
24	89/02/24	0940		
25	89/02/24	1015	Total =	
26	89/02/24	1040	260.99	
27	89/02/24	1050	tons	
28	89/02/24	1100		
29	89/02/24	1115	(Ave. 11.86)	
30	89/02/24	1230		
31	89/02/24	1235		
32	89/02/24	1240		
33	89/02/24	1255		
34	89/02/24	1335		
35	89/02/24	1410		
36	89/02/24	1420		
37	89/02/24	1430		
38	89/02/24	1435		

TABLE 5. (Continued)

Load No.	Date	Time	Net Tonnage	Measured % Moisture (Dry basis)
39	89/02/25	0735		
40	89/02/25	0810		
41	89/02/25	0815		
42	89/02/25	0855		
43	89/02/25	0920		
44	89/02/25	0940		
45	89/02/25	1015	Total =	(See preceding page)
46	89/02/25	1030	240.12	
47	89/02/25	1050	tons	
48	89/02/25	1100		
49	89/02/25	1125		
50	89/02/25	1205	(Ave. 13.34)	
51	89/02/25	1230		
52	89/02/25	1255		
53	89/02/25	1320		
54	89/02/25	1400		
55	89/02/25	1405		
56	89/02/25	1415		
57	89/02/27	0735		
58	89/02/27	0820		
59	89/02/27	0830		
60	89/02/27	0845		
61	89/02/27	0925		
62	89/02/27	0935	Total =	
63	89/02/27	0945	188.56	
64	89/02/27	1025	tons	
65	89/02/27	1040		
66	89/02/27	1100	(Ave. 13.47)	
67	89/02/27	1120		
68	89/02/27	1235		
69	89/02/27	1250		
70	89/02/27	1400		

North Cell Total = 903.11 tons.

TABLE 6. TONNAGE AND MOISTURE CONTENT OF ASH DELIVERED TO SOUTH TEST CELL

Site: Ohio Edison  
Sample Type: Ash from Trucks

Load No.	Date	Time	Net Tonnage	Measured % Moisture (Dry basis)		Field Estimate Rate of Applied Water Gal./Ton	Actual Gallons Water Applied
				<u>EMRC</u>	<u>Field</u>		
1	890407	0840	15	28-29	33.3	15	
2	890407	0950	16.21		30.4	15	
3	890407	1015	14.90		NA	15	
4	890407	1045	14.92		NA	15	
5	890407	1120	16.20		NA	15	
6	890407	1150	15.05		NA	15	
7	890407	1300	16.48		NA	15	
8	890407	1315	15.25		NA	15	
9	890407	1340	17.15		NA	15	
10	890407	1410	16.30		NA	15	
11	890407	1450	16.92		NA	15	
12	890407	1500	15.25		NA	15	
13	890407	1530	15.89		NA	15	
14	890408	0830	16.15	17-18	NA	15	3030
15	890408	0845	13.68		NA	15	
16	890408	0900	15.20		NA	15	
17	890408	0930	17.81		NA	15	930
18	890410	1220	16.95	20-23	21.5	15	
19	890410	1345	22.04	29	29	15	
20	890410	1415	15.28	20-38	29	15	930
21	890411	0800	16.56	16-19	NA	~15	
22	890411	0830	17.81	28-31	NA	~15	
23	890411	1130	20.00		NA	~15	
24	890411	1140	17.22		NA	~15	812
25	890411	1340	21.96		27.5	15	
26	890411	1355	17.22		NA	18	703
27	890411	1515	16.56		24	36	
28	890411	1530	18.22		NA	29	1140
29	890414	1030	15.87	28-29	22.5	27	
30	890414	1045	14.54	20	23.5	27	760
31	890414	1130	18.20	23-24	24	28	
32	890414	1200	19.33		NA	18	760
*33	890415	1215	18.02		NA	26	
*34	890415	1315	17.98		NA	26	
*35	890415	1430	19.29	13-14	13.5	50	2000
**36	890417	0800	14.92	42-43	42.5	~35	
**37	890417	0830	19.01	38-47	42.5	~35	
**38	890417	1000	18.51		NA	~35	
**39	890417	1015	19.73		NA	~35	2500
**40	890417	1100	12.69	39	39	~37	
**41	890417	1115	14.55	38	38	~37	1000

NA - Not Analyzed

\* - Pug Mill producing wide variation of moisture in conditioned ash.

\*\* - Moisture content by analyses not consistent with dry loads received at test cell. More water sprayed than normal to dry-appearing ash.

average capacity of 28 cubic yards. The trucks were weighed after loading and prior to leaving the plant site. The net tonnage of conditioned ash ranged between roughly 15 and 20 tons (see Tables 5 and 6).

To estimate the bulk density of the trucked ash, the largest weighed load was used together with the average volume of the trucks. The largest load was used because the trucks were often not filled to capacity. With this method, a wet bulk density of 48 lbs/cubic foot, or dry bulk density of 37 lbs/cubic foot, was calculated (assuming an average moisture content of 29.5%). The laboratory dry bulk density (loosely packed) was calculated as 38 lbs/cubic foot. For comparison, earlier estimates by B&W placed the trucked wet bulk density as 56 lbs/cubic foot. Dry bulk density measured at optimum moisture and compacted according to the ASTM D 698 was 70.8 lbs/cubic foot.

Samples were collected periodically from the trucks for moisture content determinations. These were grab samples taken at random locations. At least two splits of each sample were weighed and oven dried (100° - 110° C) from each single sample for moisture measurements. Tables 5 and 6 present the moisture contents. For example, the average moisture content for the south cell, on a dry weight basis, was 29.5%. This value represents the water content measured from oven drying at the stated temperature. It does not account for some of the waters of hydration (water taken up in the hydration of calcium oxide, calcium sulfate, etc.). This value was used to estimate the amount of water to add at the south test cell to achieve optimum compacted density. The moisture-density relations were calculated using the same method of moisture determination.

During filling of the south test cell, additional samples of LIMB ash were collected twice per day from the storage silo. These samples were composited and represent the average ash used in filling the test cell. The sampling point for this dry ash was above the conditioner and just below the storage silo. Approximately four gallons of dry ash were collected in a plastic bucket with a sealable lid on each day that ash was sent to the test cell (April 7, 8, 9, 10, 11, 14, and 17).

No problems were encountered in unloading the ash at the test cell site. The ash did not stick to the trucks and no dusting was visibly apparent. There was considerable steam generated from the warm ash, especially on colder days (filling of the cells was accomplished in February through April).

The LIMB ash was unloaded on the uphill side of the test cells. A D-5 Caterpillar was used to spread the ash across the surface of each cell shortly after being unloaded. Lifts 4"-6" thick were constructed until the cell was filled.

The north cell was completed to a thickness of 8 feet. This cell contains prehydrated LIMB ash only. The south cell was completed to a thickness of only 6 feet, due to an insufficient supply of representative ash toward the end of the LIMB test at the plant. The LIMB ash in the south cell was further wetted during lift construction. The wetting was performed by spraying each lift (stages of 3-4 truckloads) with Lorain City Water (stored in a tank truck) until the moisture in the ash was approximately 38%, which is optimum in terms of compressive strength. A specific, metered amount of water was applied uniformly across the entire lift using an adjustable spray nozzle (firehose type).

Moisture content of prehydrated ash destined for the test site was determined each day to enable the calculation and adjustment of the amount of makeup water being applied in the field. Table 6 shows the rates and amount of water applied to the lifts of ash in the South test cell in order to raise the moisture content (dry basis) to 38% optimum.

Site Instrumentation. During this quarter the major activity at the Ohio test site involved the installation of groundwater wells, neutron tubes and lysimeter instrumentation and associated coring and sampling of soils and fly ash. Two wells were installed upgradient from the test site at depths of 25' and 41' (each has a 10' screen). Each of the two test cells has a downgradient nest of 3 wells installed at depths of 33', 23', and 13' (each has a 10' screen). The wells give screen coverage from the water table to 30'

below it. Neutron tubes were installed to depths 2' below the base of the fly ash in each of the four corners, in each of the two test cells. Two nests of lysimeters were installed in each of the two test cells. Each nest provides depth coverage of 1', 3', 6', and 10' in the north cell which has 8' of ash. In the south cell, which has about 6' of ash, each nest covers 1', 3', 5', and 8' depths. All wells, neutron tubes, and lysimeters have locking caps.

Core samples and bag samples of fly ash and soils were taken according to the test plan. These samples were sealed in bags, put in sealed buckets, and shipped to the North Dakota EMRC. The samples were distributed for physical, chemical, and mineralogical characterization.

Meteorological instrumentation will be installed in the next phase of activity at the site. Weather records from Cleveland Hopkins Airport have been acquired in the meantime. We have received runoff monitoring instrumentation (Parshall flume) and will install it in conjunction with the weather instrumentation.

#### Colorado-Ute Site

The test cell was filled during the quarter with 8' of ash from the circulating fluidized bed (CFB) demonstration unit during performance testing on Peabody coal.

Figure 3 presents a simple schematic of the CFB process. Limestone is injected into the boiler at eight injection ports along the boiler walls and loop seals. Fly ash is collected in four baghouses, while the bottom ash is removed from the boiler combustion chamber.

Process operating conditions and coal analyses for the plant during the test cell filling period will be presented when available.

The ash handling system consists of four ash removal areas. Ash is collected and removed from the boiler economizer outlet, air heater outlet,

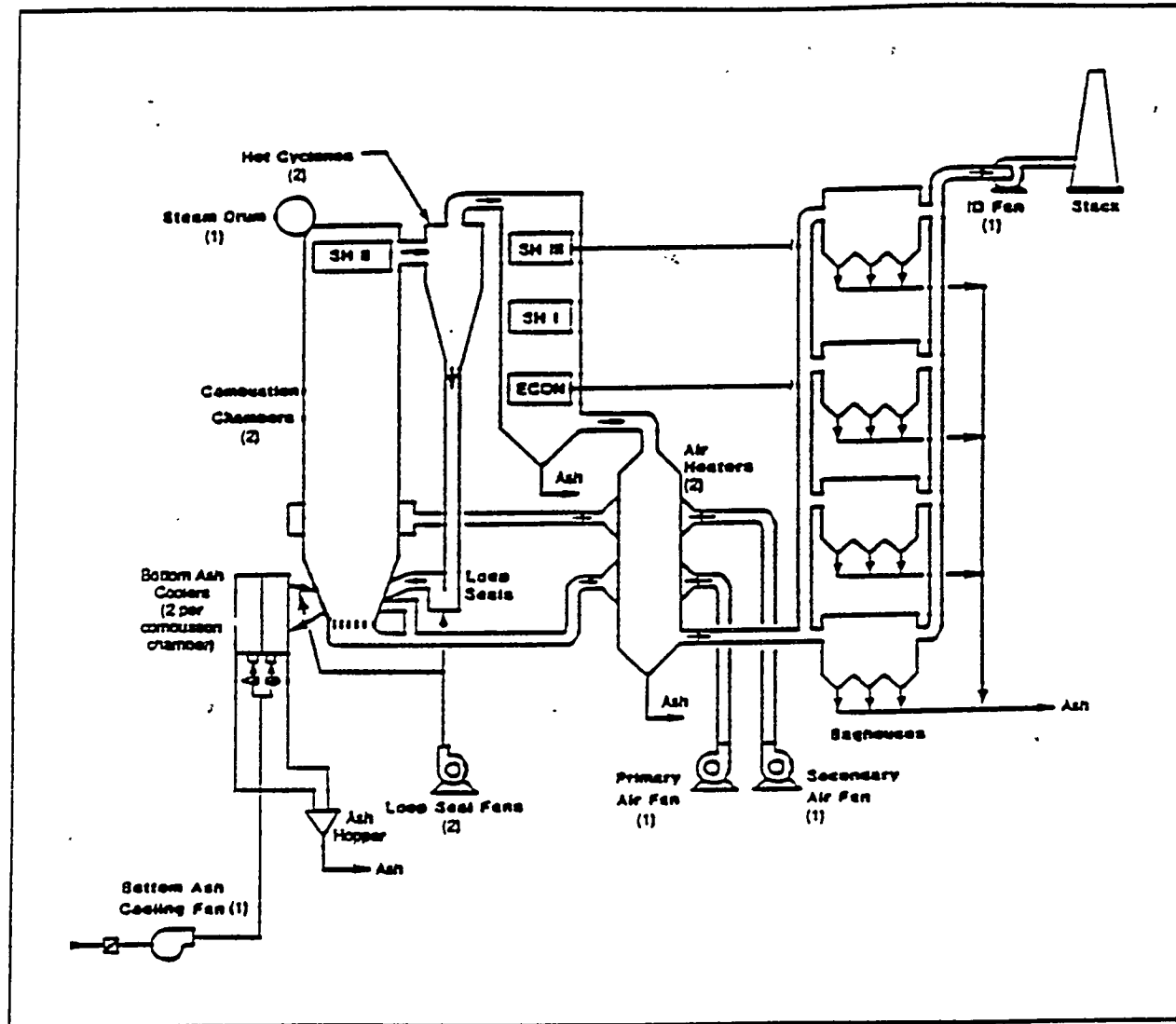


Figure 3. Schematic of the Colorado-Ute CFB Demonstration Unit

baghouse collection hoppers, and the bottom of the CFB boiler combustion chambers (bottom ash).

Ash from the existing units 1, 2, and 3 baghouse hoppers, economizer outlet hoppers, air heater outlet hoppers, and from the new unit 4 baghouse hoppers are conveyed to a new fly ash silo (60,000 ft.<sup>3</sup>). Two vacuum-type pneumatic conveying systems (30 tph) transfer fly ash from the collection hoppers to the silo.

A fly ash unloader/conditioner allows the fly ash storage silo to be emptied into transport trucks. The unloader mixes water with the fly ash to prevent dusting during unloading, transport, and disposal. The conditioned fly ash is transported by truck to a landfill disposal site located nearby.

Bed material from the bottom of the combustion chamber is removed through bottom drains located on the lower sides of each combustion chamber. Bottom ash fluidized by air from the loop seal fans is discharged into one of four (two for each combustion chamber) water- and air-cooled primary ash coolers.

The cooled bottom ash is drained from the cooler through variable-speed rotary feeders to one of two solids surge bins. Based on its temperature, the waste can be sent directly to the vacuum disposal system (ash temperature <400°F) or be diverted to a water-cooled screw for additional cooling before being transported to the bed material storage silo. The bed material storage silo (8,890 ft.<sup>3</sup>) was formerly the plant fly ash silo. An existing un-loader mixes a controlled amount of water to the bottom ash to condition it for truck transport to the landfill.

Both ashes were conditioned well enough to prevent dusting during the truck loading process. The bottom ash did generate considerable heat when water was added for conditioning. There was also visible steam evolved from the conditioned bottom ash on cool mornings.

Samples were collected from each truck load for moisture content determinations. These were grab samples taken at the unloader/conditioner as the trucks were being filled. Each sample was weighed and oven dried at 110°C. The average moisture content for the test cell, on a dry weight basis, was 39.5% for fly ash and 9.5% for bottom ash. These values represent the water content measured from oven drying at the stated temperature. It does not account for some of the waters of hydration (water taken up in the hydration of calcium oxide, calcium sulfate, etc.). Table 7 presents the measured moisture contents of the ash in the trucks as they left the plant for the test cell.

During filling of the test cell, additional samples of each "dry" ash were collected once per day from the storage silos. These samples were composited and represent the average ash used in filling the test cell. The sampling point for these dry ashes was above the conditioners and just below the storage silos. Approximately five gallons of dry ash were collected in a plastic bucket with a sealable lid on each day that ash was sent to the test cell (June 19-21).

One or two trucks were used to transport ash from the silos to the test cell. (These same trucks are used when ash is hauled to the landfill.) The trucks had an average capacity of 31 cubic yards. No truck scales were available on site, but the trucks had been previously weighed with similar loads. The net tonnage of conditioned ash was approximately 32 tons for bottom ash and 25 tons for fly ash.

To estimate the bulk density of the trucked ash, an estimated weighed load was used together with the average volume of the trucks. With this method, a wet bulk density of 60 lbs/cubic foot, or dry bulk density of 43 lbs/cubic foot, was calculated for the fly ash (assuming an average moisture content of 39.5%). Wet and dry bulk densities for the bottom ash were calculated as 76 and 69 lbs/cubic foot, respectively, based on an average moisture content of 9.5%.

TABLE 7. TONNAGE AND MOISTURE CONTENT OF ASH DELIVERED TO TEST CELL SITE

Site: Colorado-Ute

Load No.	Date	Time	Ash Type	Net Tonnage	% Moisture
1	890619	0830	BA	32	<1*
2	890619	0920	BA	32	<1*
3	890619	1005	FA	25	34
4	890619	1035	FA	25	35
5	890619	1115	FA	25	37
6	890619	1200	FA	25	NA
7	890619	1235	FA	25	NA
8	890619	1315	FA	25	37
9	890619	1355	FA	25	41
10	890619	1435	FA	25	36
11	890619	1515	FA	25	40
12	890620	0800	BA	32	10
13	890620	0840	BA	32	9
14	890620	0920	FA	25	40
15	890620	0955	FA	25	39
16	890620	1030	FA	25	40
17	890620	1105	FA	25	39
18	890620	1140	FA	25	38
19	890620	1215	FA	25	NA
20	890620	1250	FA	25	38
21	890620	1330	FA	25	39
22	890620	1405	FA	25	42
23	890620	1505	FA	25	36
24	890621	0755	BA	32	7
25	890621	0810	BA	32	12
26	890621	0830	FA	25	39

\* = Truck loaded with dry ash.

NA = Not Analyzed.

TABLE 7. Continued

Load No.	Date	Time	Ash Type	Net Tonnage	% Moisture
27	890621	0845	FA	25	38
28	890621	0915	FA	25	38
29	890621	0930	FA	25	41
30	890621	0955	FA	25	46
31	890621	1010	FA	25	40
32	890621	1035	FA	25	43
33	890621	1050	FA	25	41
34	890621	1110	FA	25	NA
35	890621	1125	FA	25	44
36	890621	1145	FA	25	NA
37	890621	1205	FA	25	NA
38	890621	1220	FA	25	NA
39	890621	1235	FA	25	NA
40	890621	1305	FA	25	42
41	890621	1320	FA	25	40
42	890621	1345	FA	25	39
43	890621	1400	FA	25	38
44	890621	1425	FA	25	41
45	890621	1440	FA	25	43
46	890621	1500	FA	25	NA
47	890621	1515	FA	25	39

NA = Not Analyzed.

No problems were encountered in unloading the ash at the test cell site. The ash did not stick to the trucks and no dusting was visibly apparent.

#### Freeman United Site

During the quarter, negotiations continued with potential ash suppliers. In addition, site access agreements were finalized with Freeman United.

#### Fourth Site

Discussions continued during the quarter between Radian and DOE on the list of fourth site candidates.

The three disposal sites already selected for this project will accommodate waste from the processes of utility AFBC (Colorado-Ute Electric Association), industrial FBC (to be chosen in Central Illinois), and advanced flue gas desulfurization in the form of limestone injection-multistage burners (Ohio Edison LIMB). Radian recommends a waste from a coal gasification process be examined in a fourth field site. Coal gasification was proposed as one of the advanced coal processes to be considered in the Test Design Manual (February, 1987), and Candidate Site Report (May, 1987).

The optimal facility for generation of coal gasification waste is one that is presently operating, is either commercial or demonstration scale, produces a waste with properties thought to be representative of commercial operations, and reflects a promising future technology. We considered three gasification bed types: fixed, fluidized, and entrained (Figure 4). In both the fixed and fluidized beds, the ash becomes oxidized from long residence time (hours) in the oxidation zone prior to exiting the gasifier. However, in an entrained bed, the ash has a very short residence time (less than a second) in the gasifier zones, and experiences a reducing gasification zone prior to exiting the gasifier. The short residence time and gasifier configuration of the entrained bed process has the unique potential to maintain reduced mineral

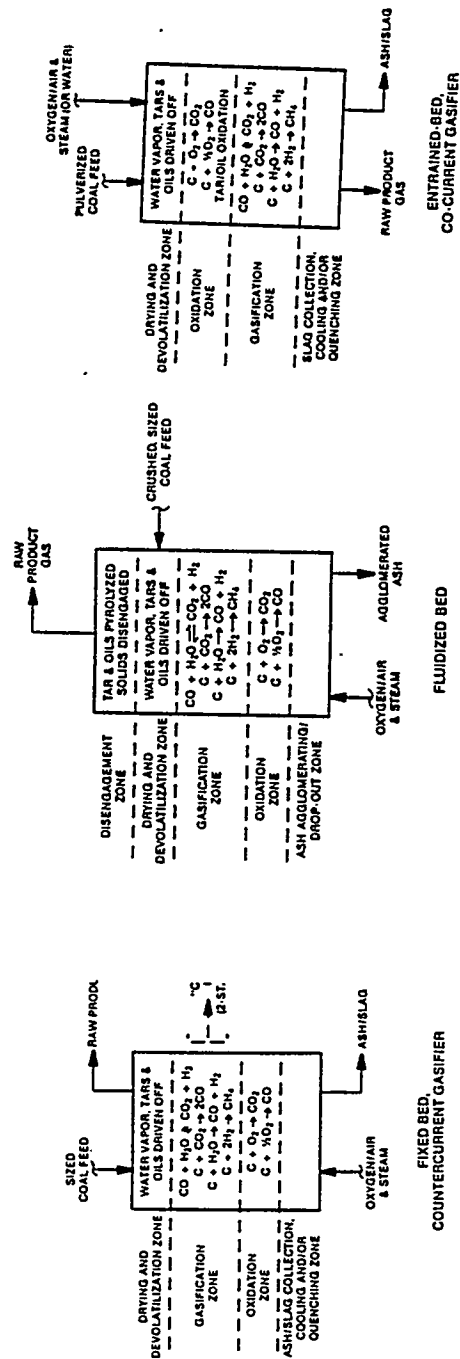


Figure 4. Conceptual Configurations of Different Gasifier Bed Types

phases from the coal to the resultant ash. Because entrained bed gasification operates at higher temperatures, the waste is in slag form and hence less susceptible to water leaching. The reduced state and slag form of this waste differs from the properties of FBC and LIMB waste which are more oxidized and unfused. Although it is uncertain which gasification process will be viable in the future (all show potential for successful use in the energy industry), entrained bed gasification waste is preferred for the fourth disposal site. The waste properties of entrained bed gasification are most dissimilar to those of FBC and LIMB waste, and therefore, the use of this waste would add diversity to the data created in this project.

The optimal environment for monitoring the performance of a disposal facility would provide data on leaching of the solid waste, and include a soil host through which processes of leachate attenuation could be monitored. Soil parameters for maximizing leaching data are high permeability, good drainage, coarse texture, a mesic temperature (mean annual soil temperature of 8 to 15°C), and a udic moisture regime (soils not dry for longer than 90 days annually).

Six coal gasification facilities are proposed for consideration as a fourth site and ranked based on fulfillment of stated requirements. Table 8 includes the primary criteria and data used to evaluate and rank each proposed site. Table 9 includes the climate and soil characteristics of the top two proposed sites.

Of the six proposed facilities, three can be eliminated based on scale and gasification process. The Texaco gasifier (Montebello) is discounted based upon its small scale. The waste from this pilot plant may not be representative of waste from a commercial scale facility. The Great Plains and Humbolt Industrial Park Facilities use fixed bed gasification processes (Lurgi, and Wellman-Galusha, respectively), and are therefore lower priorities based on their waste characteristics, and the interest the energy industry has shown in selecting fixed bed gasification for future plants.

TABLE 8. CRITERIA USED TO EVALUATE PROPOSED COAL GASIFICATION WASTE DISPOSAL SITES

Company/Sponsor	Location	Timetable (operations began)	Process Description	Waste Generation Rate (tpd)	Coal Feed Rate and Feedstock
Shell EPRI/Shell	Deer Park, Harris Co., TX	mid-1987	Entrained bed	32	250 tpd of IL no. 5 coal
Dow Chemical Co., SFG-Dow	Plaquemine, Iber- ville Parish, LA	1987	Entrained bed	288	2400 tpd of Western coal (Powder Rv. Bavin, WY)
Coolwater DOE	Dagget, San Ber- nadino, Co., CA	1984	Entrained bed	86	1000 tpd of Western coals
Great Plains DOE	Beulah, Mercer Co., ND	1985	Fixed bed (Lurgi)	1300	1,500 tpd of ND lignite
Humbolt Indus- trial Park (private)	Hazelton, Luzerne Co., PA	1985 (14 gasifiers to be built)	Fixed bed (Wellman- Galusha)	260 (projected)	Projected 1300 tpd of eastern anthracite coal
Texaco METC	Montebello, Los Angeles Co., CA	1940s	Entrained bed	1.4	15 tpd of vari- ous coals

TABLE 9. CLIMATE AND SOIL CHARACTERISTICS OF THE TOP THREE PROPOSED SITES

Company	Moisture Regime		Temperature		..Soils...	Parent Material	Permeability	Drainage
	(Average Precipitation)	Regime (Average Temperature)	Regime (Average Temperature)					
Shell	udic 46.0"	thermic 69.2°C	Hard clay	Alluvium		Very slow	Poor	
Dow	udic 57.4"	thermic 68.0°C	Hard clay	Unconsolidated sediments		Very slow	Poor	

The remaining three gasifiers are all oxygen-blown, entrained bed processes. The Coolwater Facility operates with a coal feed rate sufficient for production of waste representative of commercial scale facilities. However, the facility has recently been shut down.

The Dow Facility has the greatest coal feed rate of the entrained bed gasifiers considered (2,400 tpd). The Shell Facility has a smaller coal feed rate compared to Dow, but Radian feels the waste from this demonstration plant would be representative of waste from a commercial scale facility.

If it is agreed to pursue a fourth field site, we recommend that the initial contacts be made with Shell and Dow concerning their participation.

#### Project Meetings

A meeting was held in Austin late in the quarter with the DOE COTR and the EPRI Program Manager of the Land and Water Quality Program to discuss overall waste management studies. It was agreed that DOE and EPRI would cooperate regarding their two separate research projects. A meeting will be held in the future with additional staff from both agencies to discuss the projects.

#### 4.0 PROBLEMS ENCOUNTERED

The overall schedule has slipped due to delays in operation of the demonstration plants and problems in obtaining site access.

#### 5.0 ACTIVITIES PLANNED FOR THE NEXT QUARTER

The following activities are planned for the period of August through October 1989:

- Subtask 2.3 - Review of fourth site candidates will continue;

- Subtask 2.8 - An ash supplier will be selected for the Illinois site and subcontracts will be initiated for on-site work; and
- Subtask 3.1 - Construction of the Freeman United test cell will commence. Field testing will commence at the Ohio Edison and Colorado-Ute sites.

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